IX. *A Contribution to the Life History of* Agriades thersites, *Cantener*. By T. A. Chapman, M.D., F.Z.S.

[Read March 18th, 1914.]

Plates XXVI–LIII.

In presenting my account of this species to the Society two years ago, I promised myself, all being well, shortly to learn something about its early stages.

In 1912, however, searching for the larvae on Sainfoin, I was only rewarded by finding those of *A. damon* and *P. argyrognomon* (Ent. Mo. Mag., 1914, p. 22), and as regards the imago, though I found specimens, I did not hit off the correct place and season for success.

In 1913 I was more fortunate. I was unlucky in not meeting with the spring brood, but in July and August I obtained specimens and ova. On the 20th July I met with one specimen only, a very fresh male at Bourg d'Oisans, and so, concluding that it was only commencing to come out, I went for a fortnight or so to Le Lautaret, at some 6900 ft. of elevation, and was a good deal surprised to find *thersites* there. On the 24th July, at some 400 ft. below the Hospice, at an actual elevation of about 6500 ft., I found *thersites* on the wing amongst wild Sainfoin in full bloom, some going over, flying with *icarus*, *damon*, *escheri*, *argyrognomon*, *eros*, *minima*, *coridon*, and other butterflies. The *minima* were nearly over, as judged by numbers and condition; the *thersites* nearly all worn and damaged, with a few ♀♀ amongst them. By the 29th *thersites* at this locality were clearly nearly over. At this date I made a note of species flying with it, to illustrate that its companions were really rather of a subalpine type, and not, as I had supposed to be the rule with *thersites*, of a less Northern type than is found in the south of England. It must not be forgotten that Le Lautaret is in many respects a very exceptional locality, close to very alpine areas, for the most part subalpine in its plants and insects, but possessing many species that one hardly expects to find at such an elevation. The species noted as more or less common and flying with *A. thersites* were *Erebia stygne*, *tyndarus*,

P. eros, *icarus*, *A. damon*, *C. minimus*, *P. argyrognomon*, *A. astrarche*, *C. phicomone*, *C. arcanius*, v. *darwiniana*; rather less common or scarce, *A. niobe*, v. *eris*, *B. pales*, *M. cinxia* (very worn), *P. hylas*, *A. coridon*, *C. sebrus*, *A. escheri*, *C. semiargus*. Not many yards off and at the same level were *M. aurinia*, *C. virgaureae*, *P. apollo*, *S. carthami*. The little Mountain Tortrix, *Pamplusia mercuriana*, was also common. We find these species are both high and low level species. *Tyndarus*, *eros*, *phicomone*, *darwiniana*, *pales* are certainly mountain species. On the other hand, *cinxia*, *damon*, *sebrus*, *escheri* are by no means high level species.

On the 30th July I met with *A. thersites* in another place, a rather extended locality, but with the butterfly more frequent on certain tops of knolls where Sainfoin grew freely and was in full bloom. These knolls were at an elevation of about 500 ft. above the Hospice, or say 7500 ft., or roughly 1000 ft. above the lower habitat of *A. thersites*, where both the butterfly and the flowers of Sainfoin were already going over. On these knolls most specimens were in fair condition, but the butterfly had certainly been on the wing some days, judging by the proportion of worn specimens. I estimated that the butterfly was here 10 to 14 days later than at the lower locality, some 1000 ft. lower.

On descending to Bourg d'Oisans (2360 ft.) again, on Aug. 5th, weather prevented a successful search for *A. thersites* for some days, but from 8th to 21st it was found almost anywhere where Sainfoin grew, but usually very rarely in cultivated fields. It was in fair condition and fresh specimens were found up till the last date. The Sainfoin was, in the cultivated fields, a well-grown second crop, with only here and there a few second-crop flowers. When wild plants had not been cropped they were in seed, and the seeds were quite ripe up to 1000 ft. above Bourg d'Oisans.

A day or two at Grenoble (22nd to 25th Aug.) afforded two specimens of *A. thersites* in the Uriage Valley at a point where Sainfoin occurred both wild and cultivated, but no specimens elsewhere, though a number of *P. icarus* were scrutinised. Again, an odd specimen was found close to Grenoble where Sainfoin seemed to be wild in meadows, though it may have been a survival from its cultivation a number of years before. In any other places where there was no Sainfoin, *thersites* was not seen.

One conclusion arrived at was to confirm the idea that the food-plant of *A. thersites* was *Onobrychis* (Sainfoin) in its cultivated and wild and alpine forms. The butterfly was seen to lay on it; it was most numerous where the plant grew wild in some quantity, and though it was not found everywhere where Sainfoin was seen, it was never met with where Sainfoin was absent. Quite possibly it has other food-plants, but the observations not only gave no indication of what they might be, but tempted one to the conclusion that it had no food-plant but Sainfoin. This conclusion is certainly correct for the portions of Dauphiny explored, but there may, in other areas, be some equally acceptable plant that does not occur in these valleys.

The other conclusion arrived at is that *A. thersites* is double-brooded throughout most of its range, but at Le Lautaret it is single-brooded. It was certainly somewhat of a surprise to find the butterfly at Le Lautaret as high as 7500 ft., and a specimen or two even higher. The dates of appearance were only explicable on the idea of a single brood, as the species at 7000 ft. was going over before the second brood at 2500 ft. was fully out. At Le Lautaret the butterflies were contemporaneous with the flowering of the Sainfoin, as was probably the first brood at the lower level, the second brood coming out, when the second crop of Sainfoin (where cultivated) was nearly ready for cutting.

The specimens, single-brooded from Lautaret, and second-brooded from Bourg d'Oisans, flying at the same date, but with a difference in the elevation of their habitats of 5000 ft. did not in the field, nor do they now in my boxes, present any differences that I can detect, they are about the same size. A few measured, selected as large or small, varied ♂♂ 30–43 mm. at Bourg d'Oisans, 29–35 mm. at Lautaret, but these Lautaret specimens were (accidentally) exceptional. The ♀♀ at Bourg 27–35 mm., at Lautaret 29–31 mm. The mass of specimens were between these extremes—about 33 mm. ♂♂, 32 mm. ♀♀ at both places.

At Bourg d'Oisans *A. thersites* occurred up to about 4000 ft. (still in second brood) in warm corners on the sunny side of the valley, but, though one can by no means be certain, I don't think it occurred at elevations intermediate between this and the single-brooded high level (6500 ft.).

My bred specimens (nearly a score in number, more if the probable result of larvae given away be included) are of large size ranging up to 38 mm. in expanse, the females also are large (36 mm.) with much blue marking.

Those of Le Lautaret and Bourg d'Oisans origin were not kept separate, but the whole lot are very uniform, and both sets must be represented. They are of course either of the spring emergence or of the single-brooded race; in accordance with this I find the *androconia* are of the *escheri* pattern, with a few odd scales intermixed, varying down to *thersites* summer form.

Such trifling variation presents itself not infrequently in other species, but until looked for does not modify the impression of absolute uniformity.

Mr. Francis I. Ball finds that *A. thersites* occurs in Belgium, and has allowed me to examine some specimens. I submit a separate communication arising out of his observations of these specimens.

I entertain little doubt that in Belgium, *A. thersites* is single-brooded, and is thus brought into relation with my specimens from Le Lautaret. The specimens are rather small, ranging from 29 mm. to 35 mm. in expanse, and very similar in size and appearance to specimens of *P. icarus* which accompanied them.

The discovery of a single-brooded form at 7500 ft. and over at Le Lautaret and of the same form in Belgium makes my view that *A. thersites* has somewhat Southern climatic proclivities untenable. Its rather Southern distribution is clearly not directly due to climate, but only indirectly in so far as climate affects the distribution of *Onobrychis* (Sainfoin). When an alpine form of Sainfoin occurs at a high elevation, *A. thersites* is able to accompany it.

In the Entomologists' Record, *A. thersites* is reported from Constantinople by Mr. Graves (vol. xxv, p. 139); by Mr. Curwen, and especially in a detailed paper of some interest by Mr. B. C. S. Warren from the portion of the Rhine Valley about Bex and St. Triphon, thus much diminishing the long stretch of the valley from which I previously had no records (vol. xxv, p. 253), and (p. 301). Messrs. Buxton record the species from Greece (Epidaurus, April 21st) (Ent. Rec., vol. xxvi, p. 50); these are rather small specimens, probably of the spring brood. Commander J. J. Walker has found a ♀ specimen among the remains

of his captures at Port Baklar, near the Dardanelles, in 1878 (Ent. Mo. Mag., vol. xv, pp. 193–6).

Mr. Rowland-Brown tells me he finds in his collection specimens of *thersites* from Aosta (May), Como (June), Constantinople, Damascus, Beirut, Mende (Lozere), the latter a locality more westerly than any previously recorded, though exceeded in this respect by Mr. Moore's Poitiers specimens.

Mr. Roger Verity says he has series of *A. thersites* collected near Florence and Leghorn. "It is particularly abundant in May, becoming very scarce in other seasons of the year. In fact, I had considered it a seasonal dimorphism of *icarus*, which occurred also at other times of the year when single individuals developed in particular conditions."

I find I have a specimen (♀) taken at St. Maxime.

Mr. H. Brown, writing on 24th Nov. 1913, says that in his collecting *thersites* is commoner in the South than *icarus*. As one goes North, *thersites* becomes rare in proportion as *icarus* becomes more abundant. At Fontainebleau and Lardy, which are, though very near Paris, altogether Southern localities (one finds there *Ascalaphus*, *Mantis*, *Cicada*), *thersites* is almost as abundant as *icarus*.

Mr. Harry Moore has some examples of *Agriades thersites* from Poitiers. These are to be noted as from the most Western habitat yet reported. They are also remarkable as occurring along with *icarus*, and, as happens elsewhere in the two species, resembling each other very closely in all respects. In one point, not they really, but the accompanying *icarus* are remarkable in having, in a majority of specimens, the apical orange spot of the hind-wing advanced basally nearly as in *thersites*. On the other hand, the twin spots, of the post-discal series, at the anal angle are markedly upright in the *thersites*, typically oblique in the *icarus*.

Dr. Anton Schmidt sends me specimens from the neighbourhood of Buda-Pest of *thersites* and *icarus* taken together. On the upper sides the males seem to be identical; the expanse is from 30–34 mm. Two females, one of each species, are practically identical on the upper side. Another ♀ of *thersites* is rather small, only 28 mm., and has all the appearance of a male *medon* with somewhat reduced orange spots. The only difference I can see, is the slight and perhaps doubtful one, that the faint black centres to the orange spots of the hind-wing are near the margin as in

icarus and *thersites*, not close to the orange spot as in *medon*. The underside is definitely *thersites*. Curiously enough, of a pair of what are almost certainly *thersites* (appendages not examined) from Hungary in the collection of the Hon. N. C. Rothschild, the ♀ has these black kernels disposed very much in the fashion of *medon*, in neither specimen is there any trace of blue scales, that are never present in *medon*, frequent in the other two species.

In captivity (at Le Lautaret and Bourg d'Oisans) the butterflies laid eggs freely on Sainfoin. It was necessary as with practically all these blues to place the plant on the bottom of the cage, when they appeared to lay willingly on the leaflets, especially the undersides, visiting very sparingly upright leaves and stems, rarely laying on the calyces, never (or hardly ever) on the corollas. *P. icarus* is perhaps the least unwilling of the species I know, in this regard, to lay on leaves and flowers at some height.

The eggs of *A. thersites* are of the usual Plebeiid type, like those of *P. icarus* as belonging to this type, but differing in several definite respects. It is hardly appreciably smaller. One marked difference is in the size of the individual cells of the adventitious coat, which are a third larger in *thersites* than in *icarus*, i. e. their diameters at corresponding zones of the eggs are as 4 to 3. The columns at the angles of the cells are markedly larger, higher, and bolder in *thersites* than in *icarus*. The micropylar area is much larger in *icarus* than in *thersites*. Both these circumstances are well shown in the photograph of the eggs (Pl. XXXV). The structure of the micropylar area is affected in even a larger degree than the rest of the egg, in having the cells larger and fewer, as is evident in Pl. XXXVI. I present photographs of two specimens of each species, showing that the difference is not an individual variation.

I present most of the following notes on the larvae roughly, as entered at the time. On various points I trust to plates rather than to lengthy description.

Sept. 2. Some *thersites* hatching onwards from 8th August are now in their third skins, some from eggs laid about August 18th and hatching 26th to 27th are still in 1st instar.

When newly hatched the larva is less than 1 mm. in length, nearly colourless, a pale slaty tint, and looking semitransparent, the

hairs as a line down each side of dorsum, and a lateral series are very evident and nearly as long as the thickness of larva. As the larva grows, reaching a length of 1·5 mm., or when stretched nearly 2 mm., it develops some very distinct colouring. The ground-colour is a very pale olive-green with a nearly white band along the prominence of the lateral flange. Along the dorsal tubercles (with black bases), and again just above the spiracles, the ground-colour remains as pale bands, medio-dorsally is a broad pale brownish band hardly interrupted at the incisions; between the two pale bands each segment has a pale brownish patch of same colour as the dorsum, as are all the dark portions, or rather four small patches, one at each corner of the area, the two dorsal ones touching each other, the other two separate and having the lenticles medially on a pale area, the spiracles are each on a pale area, but surrounded by a dark nearly square patch, which is, however, sometimes actually, at others nearly, obsolete just over the spiracle, connecting the pale spiracular patch with the pale band above it, the prothoracic plate is pale and the skin points are everywhere obvious as minute black points, the hairs are colourless, glistening and spiculate, their bases and the lenticles are black and conspicuous on the paler skin.

When we compare the armament of hairs, lenticles, etc., of the 1st stage larvae of *icarus* and *thersites*, it seems at first impossible to detect any difference; there is, however, a trifling difference, in that the hairs on *A. thersites* are about an eighth longer than on *P. icarus*. So small a difference is rather astonishing after the very marked difference in the eggs, but is not really so when one observes that these larvae cannot be distinguished from those of *bellargus* and *coridon* and even *semiargus*, by any greater differences.

Pl. XXXVII and XXXVIII show the skins of the two larvae of the two species at this stage.

Sept. 5. In the 2nd instar the larva is about 1·5 mm. long approaching 2·00 according to attitude and age in the instar. In form the dorsal flanges stand out more prominently, with a flat dorsal plane between them and very definite side slopes, each rather flat, from the dorsal to the lateral flange and at an angle of about 90° to its fellow. The dorsal plane has just a trace of a central depression or valley emphasised by the large hair bases on the flange, the plane is nearly twice as wide in front (on mesothorax) as behind (on 7th abdominal), narrowing from before backwards. The hairs are more numerous, with large black bases and nearly colourless, much spiculated shafts, the colour is dark olive green, compounded of faint ochreous (pale)

pale reddish brown (dark) over greenish contents. The dorsal trough is dark, the dorsal flanges (apart from hair bases) pale. The subdorsal and supra-spiracular areas are still separated by a pale line or band, but this and the pale spaces in the two areas are smaller and less defined, so that the dark areas much predominate; below the spiracle is a dark area, then the pale lateral flange and a dark area below this, the venter being pale.

The increased armature of hairs, lenticles, etc., is shown in the photograph of the skin in this (second) instar on Pl. XXXIX.

Sept. 5. In 3rd instar it has a length of about 3 mm. (at rest) or up to nearly 4·00 if stretched; the hairs are more numerous, but proportionally (and actually ?) shorter than in 2nd instar.* The outline is much the same, both in this and previous instar it is less angular and more rounded as the larva feeds up. The colouring is very similar; there is the pale flange line, and from the posterior end of this (on each segment) a pale line passes obliquely downwards and forwards; there is the pale lateral flange line, a pale area round spiracle, and the pale intermediate line still exists, but is hardly recognisable as a line, and there is a pale patch between this and the oblique line, usually attached to the lower margin of the front end of the oblique line. The honey-gland is distinct as a transverse line with 8 or 10 hairs and lenticles round it, but not close to it.

The armature of hairs, lenticles, etc., is shown in Pl. XL. It will be noticed that the hairs of the dorsal and lateral flanges, and of the minor series half-way up the flange, are more definitely separated from each other by a considerable increase of the smaller intermediate hairs.

Pl. XXVI shows larvae at this stage. Figs. 1, 2, 3, of *P. icarus* and 7 and 8 of *A. thersites*.

Sept. 13, 1913. *A. thersites*. One specimen moulted to 4th instar on 8th and another since (11th?). They are now very short thick fat larvae; the smaller 4·5 mm. long, 2 mm. wide, 1·7 mm. high (contracted and sulky); the larger 6·0 mm. long, 2·2 mm. wide, 1·8 mm. high. Dark glaucous green, with indications of a yellowish line in each dorsal flange and a little less indistinct yellow lateral flange line, a line of rather darker marks above spiracles and a lighter green (yellowish oblique) line bordering this above, and a parallel one higher up, starting from dorsal

* Their greater length does not exceed the proportion of 8 to 7, a proportional increase would be as 5 to 3.

line (flange) at front of segment, each oblique downwards and backwards, hair points black, hairs numerous, not conspicuously longer on flanges, under surface paler, prothoracic plate deeply recessed, and so conspicuous, but not by colour, honey-gland not conspicuous, but fans indicated by a yellowish point. Head black, true legs have some dark bands on plates, but have a larger green area.

Pl. XXVI. Figs. 9 and 10 show larvae that attained this stage before hibernating. Fig. 11 one that reached this stage after hibernating in 3rd instar.

Sept. 22. The two larvae that had fed up in 4th instar and seemed to be thinking of another moult, appear to be in reality laying up for hibernation, these two were from Lautaret eggs. Three other larvae from Bourg d'Oisans eggs have also entered their 4th instar.

Sept. 28th. The three last 4th instar larvae are ceasing to feed, possibly for moult but more probably for hibernation, the two first are still quiescent; it would thus appear that the mass of larvae hibernate in 3rd instar, but that some 5 per cent. or so do so in 4th instar.

Amongst the last *thersites* eggs to hatch, a larva emerged on Sept. 7.

Hatched, Sept. 7.
Moulted for the first time, Sept. 14.
Moulted for the second time, Sept. 22.
Moulted for the third time, Sept. 30.

It then fed on and was found to be lethargic about Oct. 10. It was hoped it was going to moult for a fifth time, but it turned out that it was taking up the attitude for hibernation.

The advance of certain larvae to the 4th instar before hibernation led me to hope that some were going to complete their transformations in the autumn; this proved not to be the case.

It is worth noting that both Lautaret (7000 ft. single-brooded) and Bourg d'Oisans (2600 ft. from second brood) larvae passed on to 4th instar in autumn and hibernated so. In putting them in refrigeration for the winter I did not keep the two sets of larvae any longer separate, but when brought out and fed up, there were no differences observed to cause regret at this oversight.

It is very probable that other Lycaenid larvae hibernate in more than one instar, and this may account for discrepancies between the reports of different observers, but I think this is the first instance in which the fact has been unmistakably proved.

When settling down for hibernation the larvae spin a little carpet of silk, to which they hold very firmly, so that if an attempt be made to remove them, it is more usual for the silk to come up with the larva than for it to be left behind. I was no doubt rather unkind in the matter of providing hibernacula, so can only report generally that they seemed to desire to get as low as possible and under some cover, as inside a curl of a dead leaf. I imagine that naturally they settle down on some dead material still attached to the root stock of their plant. Of some larvae placed on living plants and left out of doors several survived and must have been in some such place, as they duly appeared on the leaves of the plant when it was brought indoors.

When the larvae had settled down for hibernation I placed them (towards end of September) in a refrigerator, with temperature from 34° to 36° (Fah.). There was a considerable mortality (vastly less, however, than amongst *eros* in precisely the same circumstances), but I got a good share through. I brought them up about the end of December and beginning of January, and found they became active and began feeding in a few days.

I pursued this course to diminish the loss during hibernation and was encouraged by the mild winter that made it possible to get Sainfoin in satisfactory condition. Luckily no hard frost set in after I had committed myself to this course.

Sainfoin is not now cultivated in the immediate neighbourhood of Redhill or Reigate, and I have to thank gratefully several friends who assisted me in finding the plant and for supplying me with it, until I had ascertained such localities.

The following notes were made in regard to the larvae after their abbreviated hibernation. They were kept in a room usually about 60° to 66°, but sometimes down to 55° at night; under these artificial circumstances dates are of little account, though affording some indication of rate of growth, etc.

Thersites.

Dec. 18, 1913. Brought up from refrigerator two larvae hibernating in 3rd instar.

Dec. 21. One of these has commenced eating.

Dec. 25. The first has been feeding regularly and has eaten the parenchyma of a good share of 3 or 4 small leaves about 5 mm. long; it does not show any very definite difference in size and appearance. The second began to eat yesterday in the same sparing manner as the first began; they leave the upper cuticle of the leaf. Brought up a 4th instar larva from refrigerators yesterday.

Dec. 26. Two first larvae feeding, the third does not look very happy, but moves about a little; it has not commenced to eat.

Dec. 27. No. 3 began to eat last evening and has by this evening made a considerable mark ($\frac{1}{3}$ to $\frac{1}{2}$) on a leaflet over half an inch long, it leaves the upper cuticle. The other two are quiescent (for moult?).

Dec. 30. One of the two did some further eating on 28th. The 4th instar specimen made inroads on two small leaves last night; so far as appears this evening all are resting.

Jan. 2, 1914. 10 *a.m.* One of the smaller larvae has moulted into 4th instar. The larger specimen (laid up for moult) is very cryptic. I have not been able to see it for several days. To-day removed leaves from box one by one and couldn't see it, nor on going over them again; but finally saw it under a small leaflet, with which it agreed in size, and with the adjoining ones in tint and colour.

Jan. 4. 4th instar larva found this morning moulted into 5th instar, colour dark greyish or olive green, with longish pale silky-looking hairs rather abundant along dorsal and lateral flanges, also below flange and some rather shorter ones extending down slope a little way from dorsum, rather in the incisions. No definite dorsal or lateral lines.

Jan. 9. 4th instar larva is now a good size, when contracted 11 mm. long, 4·3 mm. wide, and 3·5 mm. high. Very uniform in colour, a deep blue green, a barely darker dorsal line, and a very fine yellow thread deeply placed as lateral line; the silvery hairs are still a feature of the larva, but are now spread enough not to be conspicuous.

The second larva appears to be laid up for last moult.

Jan. 11. Large larva seems nearly full grown, it is at least large and skin tight and shining. The yellow lateral line is more visible than it was (more so from below), and is very slender. The colour is a bluish green, it is 11 mm. long (retracted) and about 5 mm.

broad, and quite 5 mm. deep. Many of the hair bases are black, but the long hairs are conspicuously white, on lateral view, the dorsal prominence of each segment has a crest of these silvery hairs. The prothoracic plate is well marked out and shows conspicuously black hair-bases. The fan-positions are white spots, the honey-gland looks like a small smooth area surrounded by a close line of hairs or lenticles, on a darker ground the dorsal view shows a fringe of silvery hairs laterally similar to the dorsal crest. There is a third range of such hairs half-way between lateral line and prolegs.

Jan. 12. Seems to be looking for a place for pupation. No. 2 still laid up for last moult.

Jan. 14. No. 1 has settled (?) in a corner of box.

No. 2 moulted last night into 5th instar, prothoracic plate dark from hair-bases, hairs very bright and silvery.

Dec. 30, 1913. Brought 14 3rd instar larvae from refrigerator into warm room (54°–56° night, 66°–68° day temperature, sometimes near 70°).

Dec. 31. Two larvae have already made marks on the leaves provided, one having an area of quite two square mm.

Jan. 1, 1914. About 7 or 8 appear to be feeding.

Jan. 7. One larva has moulted into 4th instar.

Jan. 12. There are now 12 of these larvae, nearly all in 4th instar.

Jan. 13. Several of these larvae show a distinct yellow line down each dorsal flange.

Jan. 6. Brought up 3rd instar *thersites* and two 4th instar.

Jan. 7. One (at least) of 3rd instar is feeding.

Jan. 12. All above grown, and most now laid up for moult.

Jan. 14. One of 4th instar moulted to 5th, hairs very silvery and white.

4th instar. Description from a larva reaching this stage after hibernation. Length 7 mm., width 3 mm., height 2·5 mm. Is very like full-grown, last-skin larva in dark green colour, more or less obscure yellow lines; when laid up for moult shows the same flattened plateau ranging over segments to 6th abl. on slopes, level and polished, and with the hollows within on each segment. It differs from the last skin in the hairs, including a good many dark ones especially on dorsal ridges, and in the black hair-bases being more conspicuous.

Last instar, half grown.

Length 12·5 to 13·0 mm., width 4 mm., height 3·8 mm. Colour bluish green, with indications of yellow dorsal and lateral (very narrow) sunk lines, a faint indication on each segment of 3 pale lines obliquely downwards and backwards. Hairs white, except on thorax,

where they are somewhat fuscous, the hair-bases are black on some of them, some appear to be white or the effect is of the short white hairs, which are very noticeable on lower parts of slope and on last four segments; head black, legs pale with black marginal line to joints. The upholstered hollows are without the raised flat margin seen when quite full grown.

When first moulted to last skin the white hairs are massed together and have a very brilliant silvery look, at first all are very white, but after, say, twenty-four hours, those on thorax are shaded with fuscous.

In some specimens the prothoracic plate looks dark, but this is due to dark hair-bases.

Side by side the green colour is very similar to that of *icarus*, but in *icarus* is slightly paler and yellower.

Jan. 24. Full grown.

Length 11·5 mm. when contracted, 4 mm. high, 5 mm. broad, rather dark bluish green, with faint suggestion of yellow sunk in dorsal ridges and more distinct very narrow lateral line yellow, but so sunk as to be almost greenish. Mesothorax projects hood-like over prothorax (when contracted), with 7 following segments it forms the 8 dorsal humps (as seen laterally), seen endwise the dorsal furrow is shallow, but hairs make the ridges look higher and the furrow consequently deeper than it is. On each segment to 6th abl. the "slope" has a raised centre from dorsal ridge to below spiracle, in this are three depressions, an upper, a middle (rather behind them) and a lower, in which is the spiracle. The depressions ("upholstered" hollows) are connected together sufficiently to give the raised area rather the appearance of a marginal cincture. This condition is often exaggerated when the larva is quite mature (Pl. XXXII, figs. 7, 8.) The honey-gland is an obscure narrow line, the positions of fans obvious, spiracles hardly different from ground-colour, white of hairs less brilliant than before being full fed.

In the last skin some specimens as they get full grown show a slight rufous tint on the white hairs and specimens differ a good deal in the visibility of the yellow dorsal and lateral bands. In the last skin, they are fond of eating the petioles of the leaves.

The feature of the larva in the last instar is the white or silvery haze round it and over it from the whiteness of the hairs, which remains so till the larva is quite half grown in this instar, when growth separates the hairs and diminishes the effect, and as it gets full grown, the hairs

become faintly rufous. The light aspect of the larva is assisted by the greater abundance of medium-sized hairs as will be seen in Pl. XLVI. (Pl. XXVI, fig. 12, and Pl. XXVII.)

Mr. Main's photographs of the larvae and pupae of *A. thersites* and *P. icarus* are very instructive in some points, and so I present them. They are in several instances stereoscopic, and the figures are placed close enough to be easily combined without the aid of a stereoscope. They are all $\times 2$.

They bring out very distinctly the much brighter appearance of *A. thersites* (larva) owing to the absence of dark hairs on the abdominal segments and the greater abundance of the larger secondary hairs. The pupae of the two species are very much alike, the larger size of the *icarus* pupa shown is an individual not a specific difference.

When first moulted into last instar *P. icarus* has white hairs except on thorax (like *thersites* mature plumage), but in a few hours, some 7 or 8 hairs on either side of each segment on the dorsal ridge become black, and most of the long hairs on the lateral flange become nearly black, often in both cases remaining pale close to the body. The pale spiracles are more conspicuous, and the yellow dorsal and lateral lines are barely to be detected. (Pl. XXVI, figs. 5 and 6.)

The photographs of the honey-gland region of *thersites* and *icarus*, Pl. XLVI, are from specimens that agree with several others of each species in showing certain differences that may be taken to be constant in the last instar.

In *thersites* on the dorsum of 6th abdominal segment are 5 long hairs on each side, in *icarus* at least twice as many, on 7th *icarus* has two strong hairs above spiracle that are wanting in *thersites*, which also has none on dorsum of 8th where *icarus* has a pair. On the other hand, *icarus* has a very moderate supply on these segments of medium and small hairs, compared with their abundance in *thersites*.

The photographs of dorsal hairs (Pl. XXII) are difficult to compare, for it so happens that the skin of *icarus* is spread or stretched nearly twice as much as that of *thersites*; so that only the posterior half of the segment is shown of *icarus*, the whole width of the segment in *thersites*.

They show, however, that the long hairs of *icarus* are longer than those of *thersites* (about 0·6 mm. to 0·48 mm.), that smaller hairs are much more abundant in *thersites*,

and that in *thersites* the bases of the smaller hairs are much more stellate in this region, differences that other specimens support.

The other photographs probably explain themselves as well without as with a description.

Pl. XLV is perhaps interesting as showing how much clearer a cast skin (when it can be unravelled) may be than a prepared one.

Perhaps the very good presentment of the special angular hairs of the prothorax on Pl. XLII and XLIII are worth noting.

Jan. 31, 1914. Newly moulted pupa.

Length 10·5 mm., a slight waist at 1st abl. 4·5 mm. from anterior end, height at mesothorax 4·0 mm. and to waist, thence rising to 4·5 mm. at 4th abl. Thoracic width 4·0 mm., increasing from waist to 4·3 mm. at mid abdomen (3rd and 4th segments). Colour rather olive green, darker dorsal line, which is really dorsal vessel, and can be seen to pulsate about 27 in a minute, actual darker spots occur half-way between dorsum and spiracles, associated with a slight hollow; one of this series occurs just above wing-base on mesothorax, head, wings and appendages are a paler more pure green, rather transparent, the wings very much so, all the tracheae being very distinct.

The larval skin adheres to last segment, the pupa is otherwise free and the skin happens to have retained no hold.

Feb. 3. There are now three pupae and the most of the remaining larvae are quite full fed or fixed up. Saw one specimen completing its moult to pupa. This one and another larva had a " girth " consisting of apparently only one strand of silk; several had some traces of silk on adjacent leaves, as for an abortive cocoon; one or two were placed where no material for a cocoon was available, and one or two appeared to spin no silk at all. Some remain a slightly darker duller green up to pupation, one or two assumed quite a dark tint.

Feb. 3. Of half a dozen larvae placed on plants in the open, three are found alive, two in 3rd and one in 4th instar.

Feb. 9. All the indoor larvae have pupated, except one or two that are laid up for pupation. There is, how-

ever, one exception, this is a larva that is at rest on a leaf of Sainfoin and has been so for over a week, and was possibly more or less at rest for some time before, but was only noticed as failing to grow. It seems to be in 4th instar, and its procedure seems to suggest that it thinks it ought to hibernate. It is in same room as others 59°–61° night, 61°–70° day temperature.

Nine days later this larva died. It probably wished to hibernate, but the temperature was too high.

Feb. 13. Examining a number of pupae shows some little variation in colouring, to some extent due to differences in maturity, the tint is usually a very light olive green, verging to pale ochreous, with the head almost always pale brownish, contrasting with the rest of the pupa; the wings are paler, or rather more colourless, at first transparent with greenish contents, later looking more solid and white, one specimen has quite a pink shade along all incisions. The dorsal vessel in mature pupae is narrower and looks more deeply sunk in more solid tissues and contractions are not evident, the mature pupa does not show the subdorsal spots noted in the newly changed pupa. In most but not in all specimens the larval skin is adherent to the last segments.

Some trace of cocoon is usually present. The larva gets beneath some leaves or paper (these were the only materials provided), and attaches these together with a good many threads, but really a trifling amount of silk altogether, and usually several threads may be called a girth; these are more evident when the larva is more exposed and "a cocoon" is absent, even four or five threads occur, but all separate, mostly only one or two. No feature evident to the unaided eye or even by aid of a hand lens distinguishes the pupa from that of *icarus*, or except size from *coridon* or *thetis*.

Feb. 26. A pupa that had turned practically black, as all do as the period of emergence approaches, showed a series of ochreous marks along the wing margins exactly suggesting the orange spots of the ♀, this was yesterday; this morning it has emerged, a ♂.

Feb. 28, 11 *a.m.* A pupa close on emergence shows the orange spots of the ♀ unmistakably and must necessarily be a ♀, in places the black colour has given place to a pale and greyish tint, chiefly over the abdomen and wing-bases, this change is due to the hairs and scales more or less

parting from the pupa case and some air being present between; this pupa shows the abdominal incisions 2–3 (doubtful), 3–4, 4–5, 5–6 and 6–7 (distinctly) open dorsally, 4–5 and 5–6 all round. By "open" I mean the stretching that occurs at this stage, when the adjacent segments are "free."

This pupa emerged at 11·55.

Another pupa (3 *p.m.*) shows very evidently the underside spotting of the upper wing, two others very dark, about same stage, show only uniform black colouring.

For 24 hours before emergence the ends of the antennae are seen to recede about 0·3 or 0·4 mm. from the extremities of their cases.

Feb. 22. First butterfly (♂) emerged. This not from the earliest larva, as it died when laid up for pupa, probably from being kept too dry.

Feb. 23. Two larvae that passed the winter out of doors are now full grown; one has very distinct and bright, but slender yellow lines along the dorsal and lateral flanges, as usual looking like threads sunk some way beneath the surface.

The dates of emergence are (not including larvae started at later dates) as under. These are only of interest as showing relative proportions and dates of emergence of the sexes.

	♂	♀		♂	♀
Emerged Feb. 22	1		Emerged March 1	1	1
,, ,, 25	1		,, ,, 3	1	1
,, ,, 26	2		,, ,, 4	1	
,, ,, 28		1	,, ,, 5	3	
			,, ,, 6	2	2

After these I had two males emerge and from larvae given to friends 1 male and 3 females appeared, making 15 males and 8 females.

Feb. 28. 11.55 *a.m.* Observed the emergence of a butterfly, a ♀. The thorax split dorsally, and by the usual vermicular movements of the abdomen, the abdomen progressed forwards, pushing the thorax in front of it, but the head remained capped by the pupal headpiece, so that the effect was to bend the butterfly in such a way that the thorax protruded dorsally, the pupal thoracic pieces being forced widely to each side, until the wings

became largely exposed on either side, and the forward segments of the abdomen; during the later part of this evolution, the wings several times at intervals made jerking movements, as if the butterfly thought it could fly.

The bending back of the butterfly was during this same later stage accompanied, or one might say relieved, by a bending forward of the front of the pupa, made easier by the wide dorsal opening of the thorax. Suddenly the object of the wing jerks became evident, as on one of them the head slipped clear of the pupal headpiece, as a result of the sudden shake, and the legs at once came out and in a couple of seconds the butterfly was clear of the pupa, and in about 7 minutes more the wings were fully expanded. If I have made the effect of the bending process clear, it will be realised that it had only to go a certain length, for the head to slip out of the cup-like pupal cover; the jerking process obviously made this occur distinctly earlier but it would have happened without it. The wide dorsal opening of the thorax was very striking in view of the empty pupa case taking so closely the form of the living pupa.

There is considerable variation in the time taken in expanding the wings, from 7 or 8 to 15 minutes, and also in the method of escaping from the pupa. As the pupa matures the wings assume an ivory opacity with a somewhat yellow or sallow tint, and the head, thorax and abdomen become dark, gradually the whole pupa becomes nearly black, but the blue tint of the wings is often visible and the rings of the antenna; this condition exists for about 24 hours, when air begins to show itself between the insect and the pupa case, first usually about the wing-bases, then spreading down the wings, but usually leaving the hind margins of the wings touching the pupa case after all other areas are practically separate from the case. The presence of air is quite obvious, the dark pupa becomes much paler where air is present and shows the ochreous pupa case separate from the darker underlying insect; this condition may be some further 24 hours in establishing itself. Then for perhaps as much as two or three hours before emergence, the incisions between the segments become extended.

The emergence of a specimen was again noted at noon on March 6. The pupa showed the case as pale, somewhat separate from the insect beneath, the hairs over the ab-

domen and the wing colours being evident. The incisions behind abdominal segments 2, 3, 4, 5, 6, and 7 were extended, the last not quite so evidently as the others. This extension is no doubt achieved by inflation of some internal spaces with air. The pupa was stimulated by placing it in the sun and at 12.10 the mesothorax slit down the back and some blue hairs, apparently quite dry, appeared. These showed some jerky movements as if the insect were trying to flutter its wings, but no sign of peristaltic movement was observed, the hairs of the abdomen maintaining their positions within the pupa case quiescent and unchanged. At 12.14 the prothorax was obviously slit, and the line of hairs was rather wider, occasional fluttering movements continued, and at 12.15 the head was free, the dorsal slit not widening as in the emergence previously observed, and the head freeing itself before the thorax had made any very obvious advance, and whilst the terminal segments had in no degree left the hinder segments of the pupa. At 12.15 the legs were free and the insect had quite left the pupa case at 12.17. Up till the freeing of the legs, which then assisted the emergence, the process seemed to be entirely by expansion of the bulk of the insect and not as a result of segmental or peristaltic movements; more air being secreted inwardly, or that already there expanding under increased temperature. At 12.27 the wings were fully expanded. Some small drops of turbid, but not thick fluid were expelled shortly after emergence and again after the wings were expanded, but there was no deposit in the pupa case, nor in any other pupa examined.

A ♂ emerged on March 3rd that varies by having the spots beneath very weak, of the first discal row of hindwing, the 2nd is a mere dot, and the 4th and 5th (in white dash) and the 7th and 8th are absent. (Pl. LI, fig. 1.)

I had given up the pupa of this specimen as ill or dead some days previously. Several days before, when the wings were in the ivory stage, one wing-base, about a fourth of the wing, became nearly black, when one would have expected both wings to become so all over in ordinary course, and things remained so for at least two days, and the blackness was attributed to one of the fatal disorders with such change of colour beginning at one place, to which larvae and pupae of Lycaenids are liable; then quite the wing-base on the other side became black, and next

day the whole pupa darkened, but one could not guess whether owing to the extension of ailment or to the ordinary progress of development before emergence, the latter proved to be the case. The original black patch must therefore have been a precocious maturing of the one portion of wing, owing to some cause that also produced the variation noted in the imago.

The presence in the pupa of a dorsal headpiece is evidence that the pupa is not highly evolved, but the opening for emergence of the abdominal incisions before the 4th shows a more primitive condition than occurs in any obtect pupa of the *Heterocera*.

The pupa of *A. thersites* presents at least as great an elaboration of the maxillary pocket as I have noticed in any other pupa, which has led me to observe certain facts in connection with it that I ought to have seen before but overlooked. (Pl. LII. and LIII.)

I first called attention to this "pocket" in Tutt's "British Lepidoptera," vol. x, p. 226, and in the Ent. Rec., vol. xxv, p. 165, I related how it is formed as observed in the pupal moult of *Agriades coridon*.

The overlooked circumstances are, that the intersegmental membrane of the two following incisions presents certain involutions and persistences in some species, that do not seem directly associated with the present development of this pocket; these are well marked, for example, in the pupa of *A. bellargus*, in which there is a very definite and symmetrical fold in the next (5–6) incision just below the pocket and a longer but shallower one in the following incision (6–7, abdominal segments), and similar involutions, on a slightly smaller scale in the same three incisions half-way between the mid-ventral line and the spiracles. It is not easy to suppose these latter have any direct relationship to the pocket.

In my original figure of the pocket in *P. argus* (*ægon*),* the extremity of the pocket and two obvious folds in the next incision, suggest a strong approach to the condition in *A. thersites*.

In *A. thersites* the involutions of the membrane, as what may be called subsidiary pockets, are almost exactly the same as described above in reference to *A. bellargus*, where the development of the pockets between segments 5 and 6 is very easily seen.

Though I call these pockets they are really merely folds, *i. e.* the two walls touch one another and contain no cavity. This second pocket in *A. thersites* is very large and looks at first glance as if

* Tutt's Br. Lep., vol. x, Pl. XXXIII, reproduced Ent. Rec. *l. c.*

the end of the true pocket entered it, since the pocket is so long as to overlap it. In *A. thersites* the extremities or extreme tips of the antennae also enter the pocket. This is probably the case in other pupae of this group in which the ends of the antennae terminate, not in a point, but by a square end as seen on the pupal exterior.

I do not know how the imaginal skin over the venter of the fifth abdominal segment frees itself from this pocket, no trace of this condition exists in the imago, unless the circumstance that the ventral plate of the fifth abdominal segment is the smallest of the series has some relation to it.

Explanation of Plates XXVI, XXVII.

[*See Explanation facing the* Plates.]

Explanation of Plates XXVIII–LIII.

Plate XXVIII. Top of the Valley of the Guisane, just below Le Lautaret, showing (+) habitat of *A. thersites* at about 6400 ft.

Plate XXIX. Looking down on Le Lautaret from the west, where *A. thersites* occurs at about 7000 ft.

Plate XXX. One of the low ridges west of Le Lautaret where *A. thersites* occurs at about 7500 ft.

Plate XXXI. Photographs of larva by Mr. H. Main.

Fig. 1, *P. icarus*; figs. 2, 3, 4, 5, *A. thersites*; × 2.

The most striking difference between the last stage larvae of *thersites* and *icarus*, as seen by the naked eye or with a low power hand lens, is that the dorsal hairs on the abdomen of *thersites* are colourless, and often glisten like silver, whilst those of *icarus* include many black hairs.

In this and the following plates, the white hairs distinguish *A. thersites*, and give *P. icarus* a dull dingy aspect in comparison.

Plate XXXII. Photograph by Mr. H. Main.

Figs. 1 and 2, as also 3 and 4, are stereoscopic of *A. thersites* larva (full grown) × 2.

The pupae are also stereoscopic by pairs × 2.

Figs. 5, 7, 9, 11. *P. icarus*; figs. 6, 8, 10, 12, *A. thersites.*

The different size of these pupae is an individual accident.

Plate XXXIII. Figs. 1, 2. Larvae of *P. icarus*, stereoscopic.
3, 4. Larvae of *P. icarus*.
5, 7. *P. icarus*, pupa.
6, 7. *A. thersites*, pupa, stereoscopic, in pairs, all × 2.

Photo by Mr. H. Main.

Plate XXXIV. Figs. 1, 2, 3. Imago of *A. thersites* from life.
4, 6. Pupae of *P. icarus*.
5, 7. Pupae of *A. thersites*, × 2.

Photo by Mr. H. Main.

Plate XXXV. Left side of Plate. Eggs of *A. thersites* × 60 and × 30.
Right side, *P. icarus* similarly magnified.

Plate XXXVI. Micropyles × 350.
Figs. 1, 2, *A. thersites*; 3, 4, *P. icarus.*

Plate XXXVII. Skin of 1st stage larva of *A. thersites* × 60.

Plate XXXVIII. Skin of 1st stage larva of *P. icarus* × 60.

Plate XXXIX. Skin of 2nd stage larva of *A. thersites* × 60.

Plate XL. Skin of 3rd stage larva of *A. thersites* × 30.

Plate XLI. Skin of 4th stage larva of *A. thersites* × 16.

Plate XLII. Fig. 1. Skin of prothorax of last stage larva of *A. thersites* × 35.
2. Prothoracic plate of same specimen further enlarged × 100.

Plate XLIII. Fig. 1. *A. thersites*, last five segments of larva in 4th stage × 35.
2. A proleg of full-grown larva × 100.

Plate XLIV. Fig. 1. *P. icarus.* Prothoracic plate last instar (to compare with Pl. XLII, fig. 2) × 100.
2. Last four segments of 4th instar, from a cast skin. The 4 spiracles will give the correct orientation.

PLATE XLV. *A. thersites.* Honey-gland region × 100.
FIG. 1, from a skin cast at pupation.
2, from a prepared skin.

PLATE XLVI. Honey-gland region, last instar × 35.
FIG. 1, *A. thersites.*
2, *P. icarus.*

Many more small hairs and lenticles are present in *thersites* than in *icarus*, but various large hairs present in *icarus* are wanting in *A. thersites.*

PLATE XLVII. Dorsal hairs of 3rd abdominal segment × 100.
FIG. 1. *A. thersites*, whole width of segment.
2. *P. icarus*, posterior half (only) of segment.

The comparison is difficult by the skin of *A. thersites* having been less extended than that of *P. icarus.*

PLATE XLVIII. Pupa of *A. thersites.*
FIG. 1 shows the dorsal headpieces consisting of two fusiform portions attached to front of head × 44. In other specimens these pieces are attached to prothoracic piece, as is in other species the rule.
2. Portion of sixth abdominal segment showing rosettes, which are not abundant on this pupa × 200.

PLATE XLIX. Pupa of *A. thersites.*
Region of (Fig. 1) fifth and (Fig. 2) sixth abdominal spiracles × 100.

PLATE L. Pupa of *A. thersites.*
FIG. 1. Cremastral area of pupa (♂) × 44. Shows sundry hairs but no trace of hooks.
2. Scar of honey-gland × 100.

PLATE LI. Photograph by Mr. Hugh Main.
Upper- and undersides of four bred specimens of *A. thersites* and of two, ♂ ♀, of *P. icarus* from the same locality as the *thersites.*

No. 1 ♂ *thersites* is a variation on the underside by diminution of spots (p. 303).

No. 2 ♂ is a variety of upperside by paleness towards wing margins, and prominence of veins between pale patches. These four specimens are now in B. M., South Kensington.

Plate LII. Fig. 1 shows the pocket in *A. thersites* as well as the one opposite its apex in the following incision, the lateral folds of the membrane, in both incisions, happen to be folded upwards, which demonstrates that they are free from the pupal wall both above and below them. They may be compared with Fig. 2, which shows the same folds in the pupa of *A. bellargus* (*thetis*). The pocket in this specimen happens to be folded upwards and not well in focus; the lateral folds and those of the following incisions are well seen. × 25.

Plate LIII is a view of this portion of the pupa of *A. thersites* from the inner surface taken stereoscopically, and so viewed shows these structures very clearly. I have numbered the abdominal segments, and have placed a letter (*a*) pointing to the pupal membrane lining the inner wing surface, which might puzzle one not used to these pupal details.

Though the greater width of these folds in one position than in another, suggests that it must be so, actual observation shows that the opening of the incisions, which occurs on the dorsum of the pupa, already referred to, does not occur ventrally, and that these folds are in no way related to such extension of the segments at dehiscence.